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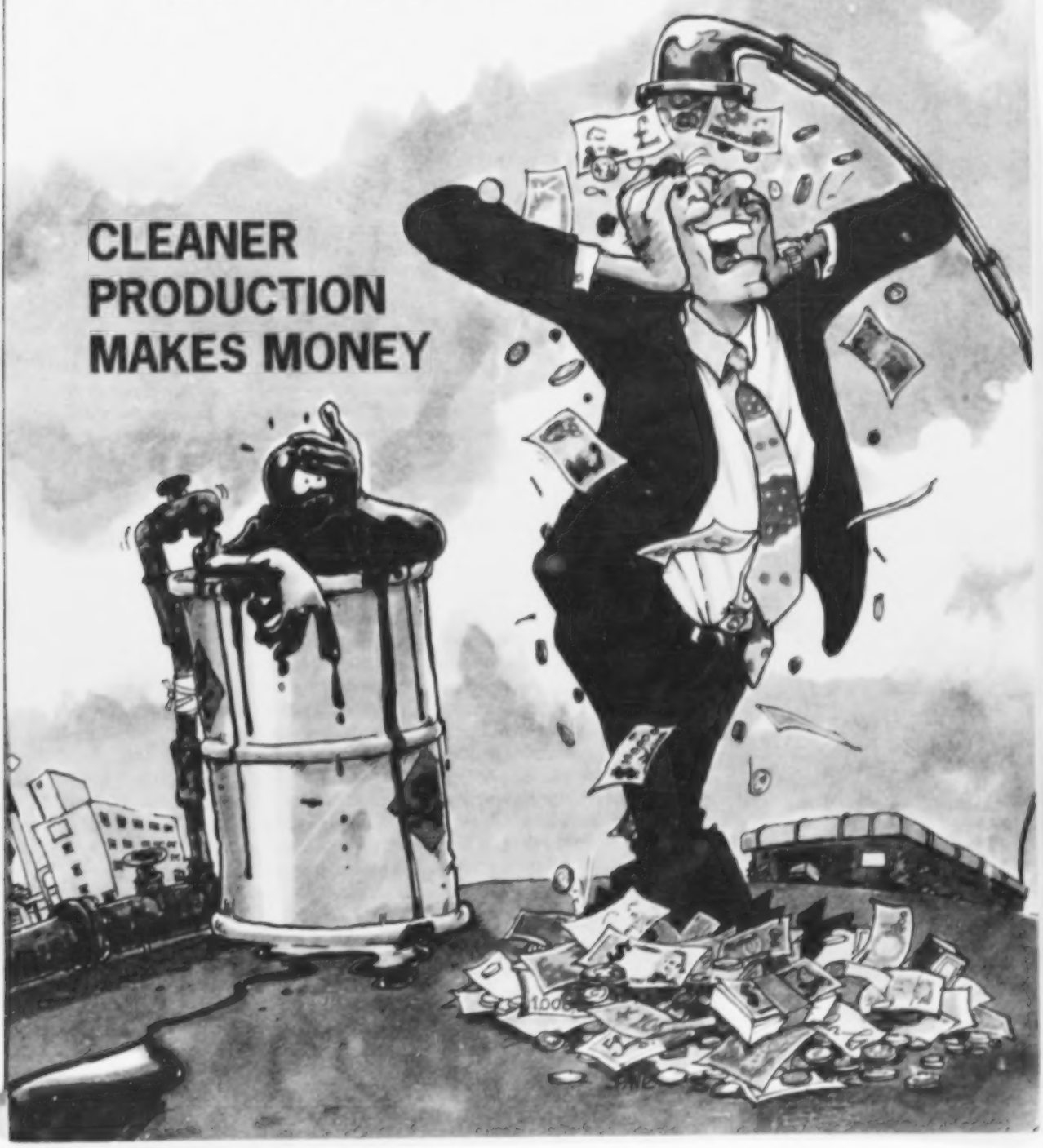
CLEANER PRODUCTION MAKES MONEY



Franklin Cardy

Desertification is back on the global political agenda. The negotiation of an international convention on desertification began in Nairobi in May 1993, and is due to be completed in Paris by June 1994.

As many as 900 million people in 100 countries are at risk from desertification. Land degradation in drylands leads to economic instability and political unrest in affected areas, and puts pressures on economies and societies outside affected areas. Management of the drylands is in turn affected by economic policies in other areas.

Billions of dollars are spent on treating the consequences of land degradation: on famine relief, refugee support and international 'humanitarian' military intervention. Desertification has global consequences. As land degrades, productivity collapses, plants die, biodiversity is lost, global climate may change and waterways clog up with eroded soil, contributing to the sedimentation of coastal zones.

To quote from last year's United Nations Conference on Environment and Development, the 'Earth Summit', held in Rio de Janeiro: 'Desertification is land degradation in arid, semi-arid and dry sub-humid areas resulting from various factors, including climatic variations and human activities'. In other words, the process we are concerned about is degradation of the Earth's productive drylands, not unproductive hyper-arid deserts. The causes of this degradation are mostly human, and are exacerbated by climatic fluctuations. It is usually a slow, wasting process—all too clear to individual farmers as yields decline, yet visible to others only when wind and water begin to erode the soil.

Because of the global impacts of desertification, its social, economic and physical scale, and the resources needed to combat the problem, progress will be made only if there is a concerted global effort. The front-line troops in this combat desperately need help, because they are generally impoverished and illiterate—and frequently female and overworked—peasant farmers and pastoralists, with little or no security of land tenure. The challenge, and the opportunity for the convention on desertification, is to provide tangible support to these people, so that land use becomes sustainable, not destructive.

In the 16 years since the United Nations Conference on Desertification, numerous action plans have been prepared and projects carried out. Community-based, local-level action plans have generally been most effective. But the problems persist, and the affected population grows. To turn from winning battles but losing the war, to winning the war itself, projects must build more on community-based action. International and national agencies must make fundamental changes in their approaches to project design, empowering the poorest, and making projects both local in scope and sustainable.

The negotiating committee for the convention on desertification has the opportunity to plan a clearly defined implementation process, supported by strong political and financial commitment, and effective monitoring. Implementation must enable those in difficulty to improve the management of their environment on a sustainable basis. Programmes must involve action, but with long-term sustainable horizons that meet people's needs. Action which attempts to combat desertification but ignores people's real needs will inevitably fail. The governments of the world have a chance to make an effective desertification control convention from which all can benefit. May they take it.

Franklin Cardy
UNEP Deputy Assistant Executive Director
and Director, Desertification Control Programme Activity Centre

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CLEANER PRODUCTION MAKES MONEY

GOING GREEN YIELDS PROFITS FOR BUSINESS IN THE UNITED STATES

SUSAN POLLACK *reports on the money that some US companies are making by rethinking their operations to reduce waste and environmental damage, and increase efficiency.*

It was not an accident that Carol Browner, the new administrator of the US Environmental Protection Agency, focused her 1993 Earth Day message on preventing pollution. Browner's talk signalled a fundamental shift in EPA priorities. Since its inception more than 20 years ago, the EPA has concentrated its regulatory efforts on clean-up and emissions control, rather than on prevention.

The EPA policy shift taps into something American businesses have been discovering for some years: it is more efficient to prevent pollution at source than to bear the costs of cleaning up a major spill or an old toxic waste dump site, or of settling a lawsuit over health claims.

Companies as different as the oil giant Amoco, aerospace contractor Northrop Corporation and Polaroid, which has made instant photographs a household word, are discovering that it pays to go green. Southern California-based Northrop alone calculates that it has saved US$20 million in hauling, disposal and raw material costs since it introduced a waste reduction programme three years ago.

But the economic benefits of re-arranging production processes to reduce dangerous waste are not always immediate. Nor are they necessarily quantifiable, says Harry Fatkin, Polaroid's Director of Health, Safety, and Environmental Affairs. 'How do you put a value on preventing something from happening? Of not polluting? Of not exposing employees to hazardous materials?', asks Fatkin.

A comprehensive US$10 million-plus Toxic Use and Waste Reduction (TUWR) programme launched by Polaroid in 1988 'does not fit a traditional economic matrix,' although in the long run, says Fatkin, the approach makes good economic sense.

Polaroid Corporation

Harry Fatkin, Polaroid's Director of Health, Safety and Environmental Affairs, has begun to meet the challenge of cleaner production.

The Polaroid effort aims to reduce the use of the most environmentally harmful chemicals (classified as Category I and II chemicals, including carcinogens and ozone-depleting agents such as CFCs) and to maximize recycling of less hazardous materials (labelled Category III, IV and V chemicals). The goal is to reduce the use and waste per unit of production by 10 percent a year for five years, as recommended by a US Office of Technology Assessment (OTA) study.

An early advocate of source reduction, Fatkin was invited in 1984 to serve on the OTA panel that produced the study. But it was not until 1986 that he was able to convince his company to change course. That year Polaroid, which has always considered itself a good environmental citizen, was suddenly hit on two fronts.

First of all, the environmental group Greenpeace issued a report lambasting the Massachusetts-based company for being the number one polluter in the state. What is more, the EPA fined Polaroid US$31 000 for violating emissions controls from its photographic coatings operation.

Fatkin says that he saw 'the futility in concentrating on trying to keep up with the regulatory rotary'. By this, he means the spiralling environmental regulations that have been aimed largely at controlling end-of-pipe emissions.

'It was clear we needed a paradigm shift,' says Fatkin. 'We could spend zillions building the most elegant waste treatment facility, but it wouldn't make a dent in the real problem.'

Polaroid spent the next two years redesigning its worldwide manufacturing process in order to start reducing pollution at source—and Fatkin anticipates that the company will continue to refine its production process for many years to come.

Polaroid sells more than US$2 billion worth of cameras, film, lenses and filters annually. In 1988, when the company introduced its waste reduction programme, it established what is now considered a cutting edge environmental accounting and reporting system (EARS). Under EARS, Polaroid employees must account for every pound of every chemical that is used, recycled or wasted.

During the first two years of its waste reduction programme, Polaroid reduced overall chemical use and generation by 20 percent—easily meeting its 10 percent per year goal—although most of this reduction consisted of category III and IV chemicals. In 1991, Polaroid began to realize reductions in the use of Category I and II chemicals; however, overall progress slowed.

Looking ahead, one of the biggest challenges Polaroid faces in meeting its environmental goals is finding a way to replace solvent-based coating systems. Right now the company is working on substituting a water-based system for an organic solvent at the Waltham coating plant in Massachusetts.

Meanwhile, on Earth Day, as Browner was pledging to make 'pollution prevention the central ethic of everything we do at EPA', she and her colleagues at the federal agency were looking towards a less embattled relationship with American business.

'Pollution prevention is not a zero-sum game,' says David Kling, acting Director of the EPA's pollution prevention division. According to Kling, the EPA has launched a series of new initiatives to encourage industry to reduce toxic waste generation, use more energy efficient lighting and, most recently, to cut greenhouse gas emissions.

Kling adds, 'In many instances, we are finding that new approaches to technology that protect the environment by cutting back on waste improve business efficiency, cut operating costs and save time.'

On another front, the EPA itself is learning that there may be better and cheaper ways to curtail pollution than those stipulated by agency regulations. This finding emerged from a recent EPA/Amoco study. The voluntary three-

In 1986, Polaroid took positive steps to redesign its worldwide manufacturing process, in order to reduce pollution at source. This action produced positive results, and is set to continue for many years to come.

Polaroid Corporation

year project, aimed at reducing pollution at Amoco's Yorktown, Virginia refinery, found that the oil company could reduce emissions more dramatically for a fraction of the US$41 million costs mandated by EPA regulations.

'The project showed that the most serious pollution problems could be solved for about US$11 million,' says Howard Klee, Amoco's Director of Regulatory Affairs. Klee served as codirector of the cooperative government/industry project with Mahesh Podar, chief of the EPA's economic analysis section. Amoco was forced to install a US$14 million waste water treatment plant, even though the study revealed that actual benzene emissions from the waste water were significantly lower than the EPA had originally calculated.

The joint study revealed that 'the most significant source of air emissions' at Yorktown is at the loading docks, where gasoline is pumped onto barges in Chesapeake Bay, according to Klee.

The study revealed that the loading dock emission problem could be corrected for US$5 million and that air quality could be further enhanced by investing another US$5 million in an improved emergency venting system, says Klee. While Amoco awaits EPA guidelines for both of those projects, it has launched another effort, which involves improving seals on gasoline storage tanks to reduce vapour emissions.

The gasoline tank seal venture cost US$500 000 and, unlike some source reduction efforts where the economic benefits can only be calculated in the distant future, this one has an explicit five-year payback period.

'We're recovering material that might have evaporated and selling it,' says Klee.

The joint EPA/Amoco project reveals without question that it makes good sense to give industry a say in how it will meet environmental goals, say Klee and Pador.

Looking ahead, Pador says, '*it may* be more cost-effective for the EPA to set targets for reducing emissions and to allow each facility to come up with its own scheme for doing that,' rather than dictating solutions from Washington.

Meanwhile, the aerospace industry's Northrop Corporation is continuing to reap the economic rewards of its hazardous waste stream by 90 percent in six years.

By January 1993, the company had achieved a 67.5 percent reduction. Financially, this translated into US$20 million savings company-wide. Some US$6.5 million alone of this savings came from Northrop's B-2 stealth bomber division.

Denny Cok Beroiz, the B-2 division's Director of Quality Assurance, says that not only has his division saved on hauling and disposal costs, it has also saved money and benefited the environment by reducing inventories dramatically. By managing inventories wisely, 'paints, epoxies, resins and other chemicals with a limited shelf life don't age out. They get put into the aeroplane and won't have to go into the waste stream,' says Beroiz.

Another big part of the Northrop programme involves recycling. One of the quickest paybacks the company realized involves the hydraulic fluid used for the flights. In the past, before a test flight, a B-2's hydraulic system was drained and virgin fluid was pumped in.

Beroiz remembers, 'I used to be charged a fee to have the used fluid hauled away and given to an off-site recycler. Now, instead of discarding it, I drain and refilter the hydraulic fluid and pump it back in. I drive away happy and the aeroplane flies.'

It cost a total of US$30 000 for labour and the filters, an investment that paid back in three months, says Beroiz. In addition, Northrop is saving hundreds of thousands of dollars a year that it used to spend having the used hydraulic fluid hauled away and reprocessed.

On another front, Northrop is now realizing savings from the revamping of the cooling towers at its Pico Rivera plant. There are 14 of these three-story *cooling towers, which run air conditioning* and plant cooling systems. Until two years ago, a biocide was used to kill algae that accumulated in the towers. Today, ozone generators have replaced the use of the biocide.

Purchasing and installing the ozone generators cost US$450 000. Since the ozone generators were installed, Northrop has saved US$300 000 a year—largely in water use—meaning that the payback took only one-and-a-half years. The B-2 division's overall water use has been reduced by 31 percent in the past couple of years, most of it due to the changeover at the cooling towers.

A Northrop maintenance worker who ordered chemicals for the cooling towers read about the use of ozone to clean up water in Europe and proposed that something similar be done at Northrop, says Beroiz. Ten months later, a team of Northrop employees, including procurement, finance, health and safety, and fire fighting people, had worked out the details for the changeover to an ozone-cooling system.

Although ozone is a major component of Los Angeles' infamous smog, Beroiz says that the ozone used in the cooling towers never reaches the atmosphere. It is absorbed directly into the water in the cooling towers, where it oxidizes the algae within microseconds. Because of the way it reacts with water, no ozone ever leaves the water.

'Plain folk, Northrop technicians, supervisors, plant workers and engineers' are given flexibility during the normal working week to explore alternatives that will reduce waste and, at the same time, 'save money for the company', says Beroiz.

For Beroiz, Northrop's ultimate goal of zero discharge, while not easily attainable, is not altogether impossible. In the B-2 division, Beroiz says, the thinking is, 'If we can make planes disappear out of the radar it's not out of the range of the possible to make by-product disappear from the production process.'

CLEANER PRODUCTION NOT JUST FOR THE RICH

Cleaner production is not just a priority preserved for industries in developed countries; it simply means being more efficient. Greater efficiency means greater profit, and all businesses want to be more profitable. Industries in developing countries also find that cleaner production makes them money.

Poland

FSM Sosnowiec manufactures car headlight reflectors, door locks and window winders. The lamp bodies are made of zinc aluminium alloy, and then copper-nickel-chromium plated. The door locks and window winders are made of steel and are zinc-plated.

The waste from the factory used to contain cyanide and the following heavy metals: chromium, copper, nickel and zinc. But then a programme to reduce pollution and improve the work conditions of the factory was introduced.

New plating processes were introduced, waste from rinses was all but eliminated and a recycling system was introduced, which allowed waste raw materials to be recovered and water reused.

This reduced the use of water and raw materials, and waste stream quantities were reduced as follows:

- chromic acid by 60 percent;
- copper by 95 percent;
- cyanide by 80 percent;
- nickel by 98 percent;
- zinc by 98 percent; and
- waste water by 93 percent.

Waste water has been purified to the following levels:

- chromium to 0.1 mg/litre;
- copper to 0.1 mg/litre;
- nickel to 1.0 mg/litre;
- cyanide to 2.0 mg/litre; and
- zinc to 0.9 mg/litre.

Capital investment in the programme was US$36 000, resulting in total savings of US$193 000 per year, with a payback period of two months. (*For more information, see page 19.*)

Indonesia

PT Semen Cibinong is a cement company near the Indonesian capital of Jakarta. It operates two cement kilns, each producing about 2000 tonnes of cement per day.

The quality of cement is determined largely by the firing temperature in the kiln. Too low a temperature, and the cement fails quality standards. Too high a temperature, and fuel is wasted, while production of nitrogen oxides (NO_x) and sulphur oxides (SO_x) also increases. Both these emissions are dangerous pollutants, the wasted fuel is an unnecessary expense and the low-quality cement is an unsaleable product—in other words, an expensive waste of money.

The company introduced a sophisticated monitoring and control system to ensure optimum efficiency in the operation of the kiln, particularly in maintaining the right temperature. This system:

- reduced energy use by three percent;
- increased production capacity by nine percent;
- reduced below-standard cement production by 40 percent;
- produced cement more readily ground to a powder, leading to further energy savings; and
- reduced emissions of NO_x and SO_x.

The US$375 000 invested saved US$350 000 per year in energy costs alone and, with the other benefits, paid for itself in less than a year.

India

Century Textiles of India is the world's largest exporter of 100 percent cotton fabrics, and it employs 7000 people. In 1991–92, its textile division had a turnover of US$99.75 million.

Sulphur black is a fabric dye commonly used in India because it does not fade much from washing or sunlight, but the traditional dyeing process uses sodium sulphide and produces foul-smelling effluents containing 30 parts per million (ppm) of highly toxic sulphides. The State Pollution Control Board stipulated that the sulphides be reduced to 2 ppm.

By substituting hydrol, a cheap and non-toxic by-product of the maize starch industry, for most of the sodium sulphide, Century Textiles reduced its sulphide emissions to within the 2 ppm limit. The new system produced higher quality cloth, eliminated the need for new investment to meet the pollution standards and saved money using the cheaper hydrol. Furthermore, hydrol produces less corrosion than sodium sulphide, meaning lower maintenance costs, and the smell of sulphide in the work place was eliminated.

CHANGING THE WAY WE THINK: CLEANER PRODUCTION IS SIMPLY BEING MORE EFFICIENT

by KIRSTEN U. OLDENBURG

Environmental protection today is evolving, incorporating a whole new strategy to try to avoid the waste and pollution that has all too often characterized industrial development. UNEP calls this prevention strategy 'cleaner production', and its Industry and Environment Programme Activity Centre (IE/PAC) is actively helping developing countries adopt it.

At its core, cleaner production is about efficiency. Efficiency, of course, has always been a human goal, but an essential environmental component has often been missing. Applying cleaner production means systematically addressing all phases of the production process and product life cycle. Cleaner production encompasses energy and raw material conservation, reduction in the use of toxic substances, and product and process changes that reduce the wastes and pollutants previously produced. The aim is fewer—and sometimes zero—emissions to air, land and water. All these actions have the same aim: to reduce fundamentally the risks to humans and the environment of industrial activities and consumption, and to do so in the most cost-effective way possible.

Unfortunately, cleaner production cannot always eliminate the generation of all wastes and emissions. At least, not with today's know-how and technology. Thus, to protect fully the environment, a new complementary prevention and control approach is required, with the constant aim of reducing risk. In this new hierarchy, the first option is cleaner production. The second option is to find ways to recycle the wastes and pollutants that still exist back into the productive system. The third option, if these are not recyclable, is to select an appropriate and environmentally sound treatment method that will destroy the hazardous characteristics of the materials. The fourth option, only to be used as a last resort, is to store what remains.

This hierarchy seems quite logical, a natural way of acting. But prevention was not part of it when environmental protection started decades ago. Only the control methods—often referred to as end-of-pipe devices (EOPs)—were devised to solve the problems of polluted waterways, toxic air, and the other results of industrial development and human activities. EOPs could be added onto industrial processes to capture and convert the pollutants they created. EOP wastes were, in turn, emitted to the air and waterways, or stored in landfills.

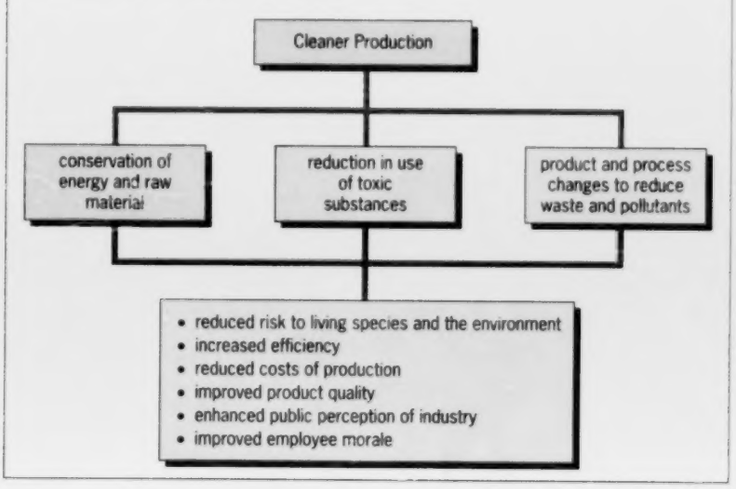
Often, these new wastes were less toxic or diluted. Little thought was given to correcting the root cause: the processes and products themselves.

As populations expanded, levels of activity grew and people learned more about toxicity. What were previously considered benign wastes were discovered to be causing environmental damage. So, over time, the volumes of pollutants kept increasing. The planet's assimilative capacity, its ability to cope with wastes, continued to be overwhelmed.

Both the public and environmentalists clamoured for tougher regulations. In response, industry complained about the associated increasing environmental costs of doing business. Cleaner production was born out of this impasse, the realization that environmental goals were no longer economically viable through the control approach.

The cleaner production philosophy started with just a few analytical reports in the mid-1980s. It was then boosted by UNEP and the Economic Commis-

Components and benefits of cleaner production


Cleaner Production
conservation of energy and raw material
reduction in use of toxic substances
product and process changes to reduce waste and pollutants
• reduced risk to living species and the environment
• increased efficiency
• reduced costs of production
• improved product quality
• enhanced public perception of industry
• improved employee morale

Adam Lane, Panos Pictures

In response to the ever-increasing volumes of hazardous wastes, the public and environmentalists clamoured for tougher regulations and triggered the concept of cleaner production.

sion for Europe (ECE) with the collection of data on low- and non-waste technologies. Cleaner production is now part of environmental policy in most developed countries and, increasingly, in some developing countries (*see page 7*). However, despite statements that it is their policy to promote actions according to the hierarchy outlined above, most governments and industries still focus greater attention and spend more money on promoting the control components.

Why is this? Moving from control to prevention has been likened to a paradigm change. A paradigm is a belief that people hold or a theory that explains events. A paradigm will prevail even when evidence is available that no longer supports it. To create the change in thinking, the evidence has to be overwhelming and many stakeholders have to be convinced.

Thus, switching to a comprehensive application of cleaner production inevitably requires a long process of education and training to cause a fundamental change in people's behaviour. Working against this change are the many forces that sustain the control paradigm, such as:

- engineering educational curricula that only teach about control methods;
- development banks that provide capital only for investments in EOPs;
- government environmental regulations that require the installation of EOP devices;
- a US$200 million environment industry that sells only EOP technology; and
- industrial firms with policies that discourage employee creativity in solving environmental problems.

But the new prevention paradigm has a mounting pile of evidence. A significant government/industry partnership in the United States, for instance, has produced a report that implants cleaner production into standard industrial practice on quality management. This report, *Total Quality Management: A Framework for Pollution Prevention*, highlights the results of a set of projects that:

- eliminated millions of pounds of pollutants from manufacturing processes;
- saved substantial sums of money;
- increased the efficiency or effectiveness of production processes;
- improved the quality of products and services;
- enhanced public perception of the company or its products; and
- improved employee morale.

The challenge now is to convince the stakeholders. IE/PAC is helping with this process, through the activities of its Cleaner Production Programme. These include information collection and dissemination, through print and electronic media (for example, IE/PAC's International Cleaner Production Information Clearinghouse, or ICPIC), awareness raising and training, and cooperative projects. One example is the establishment of National Cleaner Production Centres in developing countries, jointly with UNIDO. The goal is to encourage governments, industry and consumers to shift their focus more towards cleaner production for the benefit of all.

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OPINION

DO WE REALLY NEED ALL THAT RESEARCH?

Several years ago, during the annual meeting of a major anti-smoking organization, a number of noted researchers from various continents rose to defend the research agenda each proposed for the coming year to further the anti-smoking cause.

After listening carefully to the proposals advanced by these academic heavyweights, a petite Indian woman—a newcomer to the annual meeting—took the microphone and said, 'Why are you talking about doing more research? There is already plenty of documented evidence of the dangers of tobacco to people's health. Surely you don't need to have the same studies replicated in other parts of the world to prove what you already know and have hard evidence to support! When are you going to stop talking and do something?'

Since that time, perhaps stimulated by that seemingly ingenuous question, national and international groups worldwide have started to develop successful action campaigns to combat tobacco use.

The moral of this story is equally applicable to environmental research: eventually there comes a time when one has to stop gathering data and start doing something.

Every year, national governments, multilateral agencies and non-governmental organizations (NGOs) dole out the equivalent of millions of dollars to underwrite research in a variety of fields: environmental policy, health, agriculture, economic policy, education, social services, family planning—the list goes on. Their operating assumption seems to be that one must have all the facts about a particular problem before an appropriate solution can be designed. This process goes on in both the developed and developing worlds.

These institutes churn out research reports containing innumerable recommendations, which national governments then stockpile, either because the recommendations contained in these research studies require large sums of money to implement—money that the governments of developing countries in particular do not have—or because they suggest further research to validate the study just completed.

Until quite recently, this proliferation of research exotica was encouraged by several international donors, who believed that their responsibility, especially in developing countries, was only to fund research and to build research capacity through their grants. The question of who used the results—or whether they were ever used outside the academic enclave—was not their responsibility. However, in the face of a world recession, when Northern countries and the United Nations are deluged with funding requests from every side, competition for grants and loans from the shrinking pool of available funds is, hopefully, driving this cavalier attitude to ground.

But now, hard on the heels of the Earth Summit in Rio and the adoption of Agenda 21, a new flurry of research proposals is making the rounds of the funding agencies. Old research proposals are being dressed up in new attire, tricked out with all the new environmentally trendy buzz words such as 'ecosystem', 'biodiversity' and 'sustainable development'. And, unfortunately, the focus on environmental issues threatens to follow in the footsteps of development research.

What becomes of all this national and international research? Undoubtedly, some of the results are probably best forgotten. However, many studies contain positive results which might very well be of benefit, if only they were more widely known.

Sadly, however, many development and environmental studies were never designed to be used. Much of the research—especially in the fields of policy and social science, but also in agriculture and health—addresses esoteric academic questions with little potential for immediate application—research which falls into the 'so what?' category. And their conclusions frequently call for further research, because even the researchers cannot think of how to apply the results immediately.

In the research community, 'utilization' of research results has become confused with 'dissemination'. Initially trained as academics and grounded in conceptual ways of thinking, many researchers mistakenly assume that if they present the results of their research in a journal article or in a paper delivered to colleagues at an international symposium, they have used the research results and their task has ended. To a degree, the researcher is correct—that is, if his or her goal is self-aggrandizement, rather than the adoption of the research recommendations. But such goals achieve little in the real world.

There is no acceptance of responsibility for such ineffectual research. Researchers complain that no one uses their results;

UNEP and the rationalization of environmental research

UNEP has two programmes to coordinate and rationalize environmental research and data collation. Earthwatch is a UN-wide network of monitoring and assessment programmes, coordinated by UNEP. Data are collated, and assessments made by UNEP and other agencies which cover: air quality, the upper atmosphere and ozone, climate change, biological diversity, land resources (including deforestation and soil degradation), freshwater resources, oceans and coastal areas, human health conditions, waste and toxic chemicals, and biotechnology.

UNEP's coordinating role aims to ensure that Earthwatch provides an efficient, cost-effective and systematic flow of usable environmental data to decision makers and the general public. For further information, contact: Earthwatch UNEP, Palais des Nations CH-1211, Geneva 10, Switzerland. Tel. (41 22) 789 40 96/789 40 82, Fax (41 22) 789 40 73.

In conjunction with the German government, UNEP has also established an office to rationalize the plethora of environmental research projects around the world, and to encourage certain standards, so that different research projects can be compared.

UNEP's Harmonization of Environmental Monitoring (HEM) office in Munich has begun by collating an inventory of 213 different specialist and regional environmental programmes, with their address, phone and fax numbers. This book, published by UNEP/HEM, includes a glossary to guide the reader through the mind-numbing alphabet soup of international institutions.

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Development advisor Nancy George argues that, all too often, more research and new data collection can be procrastination or simple self-promotion in disguise—the output condemned to moulder in data gravevards and seldom-used libraries.

action-oriented agencies complain that researchers too often record their results in buzz words and academic jargon, intelligible only to other academics or that, worse yet, they will not release their research results for application because the findings are still 'tentative'.

A little less than a decade ago, the Board of Governors of a moderately well-known international development research organization decided to evaluate the impact of its research on the lives of the impoverished in the developing countries it served. After 15 years of operation, the Board anticipated hard data to prove that development research was making a difference to the lives of the poor in the South.

To its great embarrassment, the Board discovered that the vast majority of its research funding initiatives had accomplished little or nothing for the poor in developing countries: low-cost, 'appropriate' technologies, although proven in the research environment were, in the main, gathering dust; and recommended policy changes remained shelved. Those intended to benefit from the research were largely untouched.

What had happened? Surely all the money invested could not have been for naught? How could so many bright, talented people have managed so little?

In fact, the funding had accomplished a significant amount—but for the careers of the researchers, not for those the organization had intended to help. Some of the individuals involved had become ministers in their areas of specialization; others had risen to senior positions in universities and in international organizations. In the developing world, many highly regarded academics had acquired their tertiary degrees at the organization's expense.

Sadly, the groups who benefited least from this huge outlay of funds were those who were the purported beneficiaries of the research results: the poor and disadvantaged populations—who seem always to be cited as the targets of development, but so rarely are. What became clear was the huge gap between the conduct of research and the application of its results.

The reality, almost a decade later, is that the findings of this evaluation are neither unique nor confined to the one agency's experience. Even today, a review of research funded in the international community reveals that there is still a serious challenge to be met in bridging the gap between research results and their usefulness.

The obvious response to this is for funding agencies to demand that use of results be a part of all future research projects. This is easier said than done and ignores a legitimate need for some vital routine monitoring, for example of ozone depletion and climate change indicators. But there are many proposed research projects where applicability ought to be a criteria. Unfortunately, academics and researchers do not necessarily have any experience in encouraging the use of research results. The danger is lip-service to the use of the research rather than outcomes that have any impact on the real world.

The fact is, researchers are not only inexperienced in the application of their findings but, all too frequently, they are not interested in applicability. They operate on the rather naive assumption that if they conduct good research, the results will automatically be used, and they ignore how that use will occur. This is not an indictable crime; researchers and their results are only two ingredients in the recipe. However, that is not to say that the researchers can be absolved of all the blame for the waste resulting from this communication gap. Too infrequently do they sit down with potential users to identify research that might provide practical information.

Several years ago, in the spirit of South-South collaboration (before that term became another piece of 'enviro-speak'), a consultant was contracted to determine the usefulness and relevance of certain audio-visual materials based on community experiences in Africa and the Philippines, funded by the World Bank. She contacted a well-known community group leader working in the slums of Kingston, Jamaica. In reply to his invitation to help in evaluating the material, he observed, 'Excuse me for saying this, but you people are all the same. My people work 14 hours a day with the people of the community, and you want me to ask them to sit around and look at films designed to encourage them to do what they are already doing and evaluate whether they are useful? ... Frankly, I don't think they would be interested. ... you are busy defining problems to suit your solutions, while we are busy solving them.'

Particular problems exist for universities in developing countries that are struggling to establish their academic legitimacy, which magnify the circumstances in universities in the developed world. Teaching staff have competing goals: conducting research (to help build the university's reputation and so obtain more funds) and publication of research results (to achieve security of tenure and promotion).

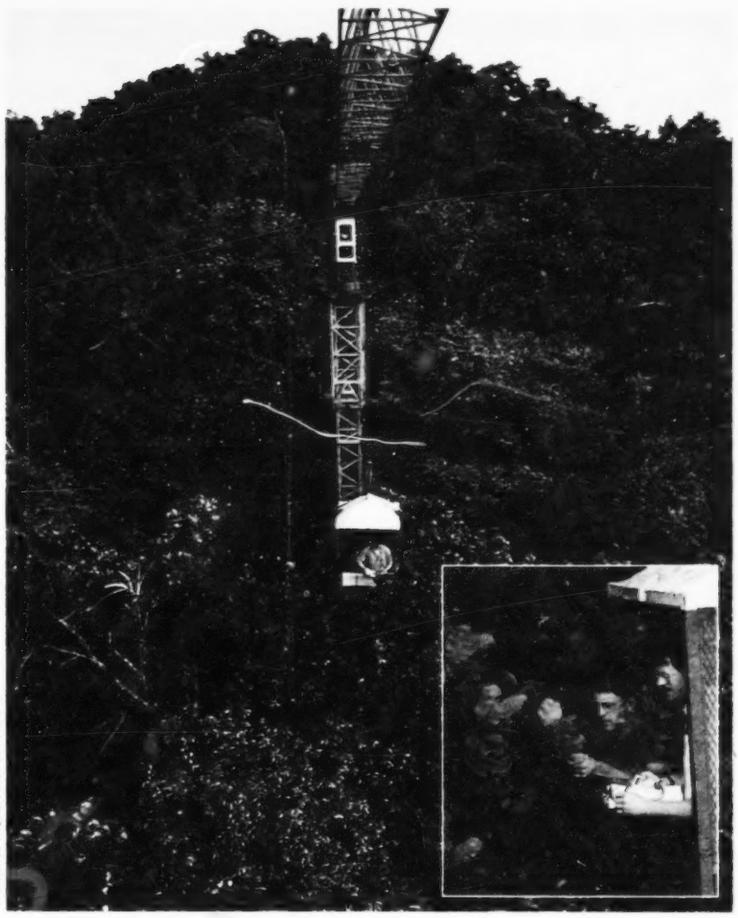
Thus, there exists a culture in many universities in the South which encourages academic staff to 'moonlight': to develop research proposals for the sake of their university careers. The research is usually 'safe' research, replicating projects already proven in the North. This stimulus for undertaking research may help the academic to keep his or her job, but does the environment little good.

In the end, to overcome the environmental challenges confronting and affecting people's lives, there will have to be a marriage between what is conceptual and what is real.

Surely it is not too soon for researchers and community developers to stop describing problems, and to begin to solve them through combined action.

The author of this article is the Coordinator of the African Research Utilization Network (ARUNET), a project which aims to make research more usable in Africa. It is currently being jointly sponsored by Canada's International Development Research Centre (IDRC) and CARE International in Kenya. ARUNET ensures that research proposers talk to potential users of their research before finalizing the design of the project.

For further information, contact: ARUNET, c/o Care-Kenya, PO Box 43864, Nairobi, Kenya. Tel. (254 2) 724 628, Fax (254 2) 728 493.



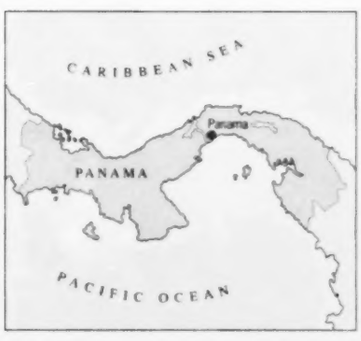
Smithsonian Tropical Research Institute

EXPLORING THE UPPER TROPICAL FOREST CANOPY

by JORGE E. ILLUECA
and ALAN P. SMITH

Estimates of the total number of species on Earth have jumped from 5 million to 30 million because of research done on the canopy of Panama's forests.

It is dawn in Panama City's Metropolitan Nature Park. Rising incongruously above this remnant of Central America's most endangered ecosystem—the semi-deciduous dry forest of the Pacific coast—is a 49-metre high, bright orange tower crane with a 55-metre horizontal jib.



This rather odd spectacle is the key to a research project conceived by Smithsonian Tropical Research Institute (STRI) scientists in consultation with UNEP in 1989. The research is on the biological diversity of the tropical forest canopy, and the possible effects of atmospheric changes on canopy plants and animals.

The tropical forest canopy is the least studied of the Earth's terrestrial habitats, largely because of difficulties in gaining safe access to the tops of trees and the outermost canopy which, in mature forests, can rise 50 metres (164 feet) above the ground, the equivalent of a 16-storey building.

The tropical forest canopy is considered the habitat with the greatest species diversity, particularly insect fauna, most of which has yet to be recorded by science, but little is known of the structure and biotic interactions of these communities. It is estimated that 40 percent of the world's species of plants and animals, many of which never visit the ground, may live in the uppermost reaches of tropical forests. Because recent samplings in the forest canopy on Barro Colorado Island in Panama produced so many new species, estimates of the total number of species on Earth have been raised from 5 million to 30 million.

Various canopy access systems have been suggested and tried, such as fixed or swinging aerial walkways. But the tower crane allows safer long-term

site observation over the whole canopy. The crane's three-dimensional manoeuvrability, stability and ability to carry equipment allows investigators to carry out new types of measurements and gather far more data than had been previously possible. The largest cranes currently available, with a horizontal reach of 80 metres, are capable of allowing studies over an area of more than 2 hectares, or more than a million cubic metres, in a 50-metre high forest.

Six study areas are being addressed under this project: forest canopy biodiversity, biotic interactions among canopy plants and animals, canopy energy balance, ultra-violet effects on the upper canopy, physiological effects of drought on canopy plants and physiological responses of canopy plants to variations in atmospheric carbon dioxide.

Approximately 100 researchers, including STRI scientists, visiting scientists and professors from the University of Panama and other Latin American countries, have participated in canopy studies or course work at the Metropolitan Nature Park. Most are graduate students from Latin America, particularly Brazil, Colombia, Costa Rica, Panama and Venezuela, but there are also 25 researchers currently working on canopy projects. Stipends and fellowships for these researchers are provided by a number of institutions and foundations.

Although the project is little more than two years old, it has already contributed greatly to our knowledge of the structure of the upper canopy of a tropical dry forest and of the eco-physiology of canopy leaves. These findings suggest the existence of a complex upper canopy structure and a wide diversity of responses of upper strata leaves to prolonged exposures to sunlight and water stress.

The findings of these studies will be available during 1993. However, current research is already throwing into doubt our conventional understanding of the structure and dynamics of tropical forests. For example, it was discovered that so dense is the layer of lianas that the crowns of some trees are completely obscured. As a result, the whole canopy sways in unison, allowing trees with relatively soft leaves to avoid the abrasion that would make them unable to compete with trees with tougher leaves. Previously, it was thought that trees with soft leaves would not be present at the uppermost level of the canopy.

Project researchers are now measuring the impact of tree shade on lianas, and vice versa. These interactions are crucial to the structure and productivity of dry deciduous forests. Subsequently, field measurements of photosynthetic light response will be made for each of the species involved, in order to assess the impact of shade on the photosynthetic rate. Another project has called into question the traditionally held view of how water moves from tree roots to the tree crown. It is intended to confirm the new findings later in 1993.

These data on photosynthesis and water movement are directly relevant to the Framework Convention on Climate Change, and the enormity of the number of new species discovered in the canopies of forests is important for the Convention on Biological Diversity. Both conventions were signed last June at the UN Conference on Environment and Development in Rio de Janeiro.

The project has been funded by the governments of Finland, Germany and Norway, through UNEP's Clearinghouse, and by STRI. Funding is now being sought to erect tower cranes in Brazil, Ecuador, India, Malaysia, Sarawak and Thailand.

For additional information on this project, contact:
Dr A. Smith
Smithsonian Tropical Research Institute
PO Box 2072
Balboa
Republic of Panama.

Project researchers are studying the relationship between tree shade and lianas. In some parts of the forest, lianas are so dense that the crowns of some trees are obscured.

Jorge E. Illueca, former Coordinator of Environmental Management at UNEP, is currently a Guggenheim Fellow at STRI. Alan P. Smith is Assistant Director for Terrestrial Research at STRI.

Panama City's Metropolitan Nature Park

The 300-hectare park's semi-deciduous, dry forest is home to unique species such as the endangered Panamanian tamarin monkey (*Saguinus geoffrey*) and the cuipo (*Cavaniselia platanifolia*), one of the tallest trees in Panama which can reach a height of 35 metres (115 feet) at maturity. Visitors can see thousands of birds, from hawks to hummingbirds, as the park is on a major avian migration route. Nearly 300 migratory and resident species have been sighted in the park.

The Metropolitan Nature Park Foundation is working with government authorities to establish a natural corridor connecting the park with the 15 000-hectare Soberania National Park 17 km to the north in the centre of the Panama Canal watershed.

FORECASTING BY ANALOGY: the Vietnamese case study

What impact might global warming have on agriculture, the mangrove ecosystem, the sea coast, fisheries, energy and human health? How can we anticipate these changes? UNEP's World Climate Impacts and Response Strategies Programme produced a series of case studies to predict how people will be affected by future climate change.

BEATRICE LACOSTE *explains how the work in Vietnam provides some useful response strategies.*

Man has always shown a great capacity for adjusting to change. Past generations have survived ice ages, floods and droughts, world wars and famines.

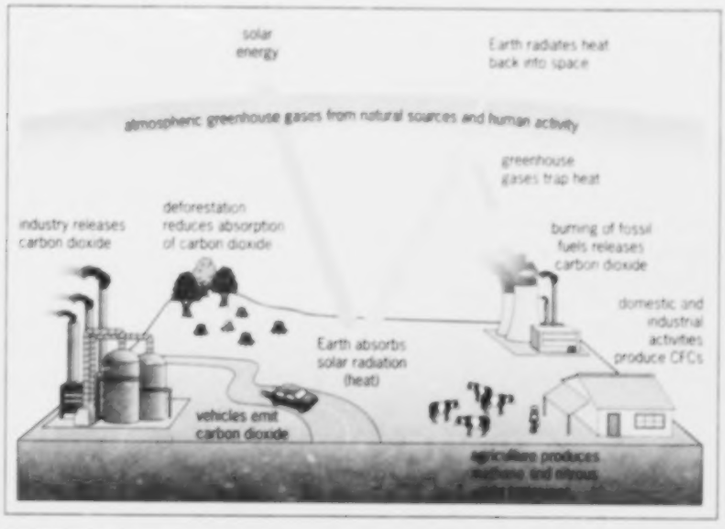
However, when the whole planet's environment is being altered, there is a great danger in relying on adaptation alone. Some global processes, such as the loss of biodiversity, are irreversible. Others, such as the climate change caused by humans, are profound.

A basic distinction must be made between weather and climate. Weather variations, including droughts and unusually cold winters are minor oscillations in our biosphere's complex system. Climate change is what will happen next century.

We are witnessing significant weather changes due to natural phenomena, such as solar variations and the persistent fluctuations of the El Niño/Southern Oscillation (ENSO) phenomenon (*see box, page 15*). But the world is also warming because of an accumulation of greenhouse gases, threatening changes in global and regional climate that are barely predictable.

Michael Glantz of the US National Centre for Atmospheric Research, in Boulder Colorado, has pioneered the use of a technique known as 'forecasting by analogy' to predict the effects on society of future climatic change. Sooner or later, humans—so used to adapting the environment to suit their needs—will be forced to adapt to the environment's demands. How will societies respond? How will the world cope with the long-term changes that are in store? Glantz and his colleagues analysed the potential socio-economic effects of climate change in Vietnam. The soon-to-be-published results are a good example of how virtually every long-term environmental change is occurring in miniature somewhere on the planet. The book also shows *Homo sapiens'* resourcefulness in coping with sweeping changes.

Today, Vietnam has 70 million inhabitants and the population growth rate is more than 2 percent per year. The rate of per capita economic growth must increase: the current standard of


solar energy
Earth radiates heat back into space
atmospheric greenhouse gases from natural sources and human activity
greenhouse gases trap heat
industry releases carbon dioxide
deforestation reduces absorption of carbon dioxide
burning of fossil fuels releases carbon dioxide
domestic and industrial activities produce CFCs
Earth absorbs solar radiation (heat)
vehicles emit carbon dioxide
agriculture produces methane and nitrous

living is low, with a GNP per capita estimated at US$250. Demographic pressure is strong, and will intensify in the future. Vietnam is a relatively small country with a total area of about 33 million hectares. The country's ecosystems range from mangrove forests and coastal beaches, and equatorial and alpine forests, to lakes and rivers. With such a variety of habitats, the country has a wide variety of fauna and flora. Vietnam has coal, oil and gas, and agriculture is a major economic activity.

Preparing for the worst

So what would global warming mean for Vietnam? Presently, climate variations seem quite strongly related to the occurrence of the ENSO phenomenon. In ENSO years, the number of storms decreases by about 20 percent, but they are more violent. Following ENSO years, temperatures in winter and spring tend to drop below average.

Other trends observed during the past 30 years include a recent increase in annual rainfall in the north and a decrease in the south, higher temperatures and a rise in sea level.

To assess the potential socio-economic effects of climate change on Vietnam, the authors used current indicators such as the ENSO events, and directly and indirectly observed climate data. These are considered to mirror long-term climate change. The authors extrapolate those trends to describe potential future climate scenarios and their impact on the population.

By the year 2060 Vietnam could have higher temperatures; increased rainfall in the north, because of more northern penetration of the summer monsoon; a drier south; higher sea levels; and more frequent storms.

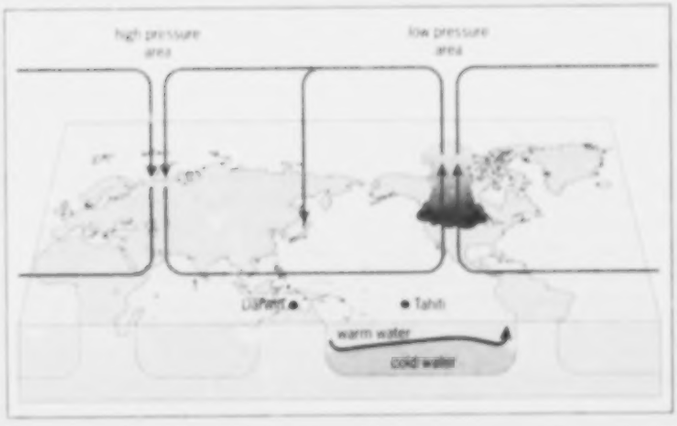
Drought, particularly in the south of the country, would be the major adverse effect on agriculture, and farmers would be restricted to a narrower range of crops. The increased temperature and humidity in winter would trigger the outbreak of pests affecting winter and winter-spring crops. In upland regions, the rise in temperatures would squeeze out crops currently grown in temperate upland areas.

What is ENSO?

ENSO refers to El Niño and the Southern Oscillation, two parts of a climatic phenomenon that brings major disruptions to global climate patterns. El Niño is the warming of the water off Ecuador, Peru and northern Chile, disrupting the normal upwelling of cold water along the South American Pacific coast. It occurs irregularly—there is a vague pattern of every five to seven years—with varying intensities and durations. The warm waters spread out across the Pacific towards Indonesia.

The Southern Oscillation is a see-saw of atmospheric pressure between the Pacific and the Indo-Australian areas. For example, when atmospheric pressure is low in the Pacific Ocean, it tends to be high in the Indian Ocean from Africa to Australia. Differences in atmospheric pressure between the Pacific island of Tahiti and the Australian city of Darwin are used to indicate a Southern Oscillation.

The two phenomena coincide, hence ENSO, and cause significant disruptions to world weather patterns, from Ethiopia to Brazil and China, to the southern United States and beyond.



One advantage, however, would be that cultivation could extend to higher altitudes, perhaps 200 metres higher for each degree increase.

'New research is needed on mixed cropping strategies to cope with climatic variability,' says UNEP climate specialist Peter Usher. 'Another point of concern is the impact of sea-level rises on agriculture—appropriate measures must be found to prevent the intrusion of salt water into coastal ground waters.' More violent typhoons and the threat of drought in south Vietnam also threaten crops.

Monsoon, temperature, salinity and rainfall exert an important influence on the spawning of some economically important fish species in Vietnam's waters, as does the ENSO phenomenon.

The total fish catch in Vietnam from 1960 to 1989 shows no major fluctuations, but more extensive studies are required in order to better understand the impact of ENSO events on marine fisheries. This will allow a more effective management of these resources.

The rise in sea level observed so far (about 6 mm per year) has tended to increase the rate of erosion of mangrove forests, which harbour a wealth of plant and animal species.

Human activities, such as the extraction of groundwater, oil and gas, the construction of dams on rivers and the over exploitation of mangroves, have often accelerated incursions of sea water.

The solution is to monitor mangrove forests very carefully and to ban the conversion of mangrove areas to

Vietnam's diverse climate

Like other developing countries, Vietnam is faced with a compelling challenge: the need to promote rapid socio-economic growth while conserving the country's natural resources. Potential climate change makes this balancing act even more difficult.

The most striking geographical characteristics of Vietnam are its long, narrow shape, its position in the inter-tropical zone and its extended coastline. Key physical features are the two river deltas of the Red and Mekong rivers, which are centres of agricultural production with high density population.

Vietnam's climate is tropical monsoon. The region is susceptible to extreme climatic events, such as typhoons. The unusual shape of the country means it extends over 15 degrees of latitude, producing a large difference in climate between the south, with its wet and dry seasons, and the north, with its four distinct seasons. The territory's long coast makes it susceptible to the influence of oceanic air masses, and its position in the inter-tropical zone provides the country with a high level of solar irradiation. An unusual feature of Vietnam's climate is the intrusion of polar air into the north during winter months, resulting in unusually low temperatures for this latitude.

These factors contribute to the richness, diversity and complexity of Vietnam's environment, but make the potential impacts of climate change difficult to assess.

shrimp ponds and agriculture. This will not only conserve the mangrove and the vanishing species, but limit sea-level rise and coastal erosion.

The threat to human health from climate change

At certain times of the year, heat and humidity are currently near the limit of what people can withstand. High humidity reduces the human body's capacity to discharge heat through the evaporation of sweat. Even a small increase in humidity and heat could have very adverse effects on human health.

In the north of Vietnam, winters are unusually cold for that part of the world because of polar air carried by winter winds.

Climate may be a direct cause of disease or it may be an agent, either encouraging or discouraging the development and recurrence of disease.

In the north of Vietnam, new ways of coping with the cold temperatures is crucial: prolonged cold and wet air causes a worsening of chronic respiratory diseases, such as tuberculosis, whooping cough and bronchitis.

But in the south, prolonged periods of very hot, humid weather can lead to a depression of immune responses. Diarrhoea and dysentery develop, and other diseases such as measles and dengue fever encephalitis occur in close connection with insect vectors.

In Vietnam, little attention has been paid to the impact of climate change on health. More research needs to be done to formulate a better healthcare strategy.

If the nations of the world take immediate action to save energy and reduce greenhouse gas emissions, curb pollution, and slow down population growth and deforestation, mankind will be better prepared for the threat of climate change.

Typhoons in Vietnam are already a problem; in the south, these threaten to become even more violent in the future.

FIGHT TO PROTECT COLOMBIAN ALLIGATOR CONTINUES

UNEP's CITES Secretariat (*see box*) is continuing its fight to protect the cayman, Colombia's unique and endangered alligator. Large quantities of skins are still being illegally exported, although a major blow was delivered to the trade at the beginning of the year, with the confiscation of 29 000 caiman skins by customs authorities in the Uruguayan capital, Montevideo.

Acting on information provided by the CITES Secretariat, and with the help of authorities on the Caribbean island of Aruba, the US$1.5 million shipment was grabbed on its arrival from Curaçao. From Aruba, the 68-bundle consignment had been destined to go to a businessman in Singapore. The bundles had been given a Colombian CITES permit, which would have legitimized the trade, but the permit was found to be a fake.

CITES' South American officer, Obdulio Menghi, said the Secretariat was very pleased at the success of the Montevideo operation. But, he said, '... we are still worried by the fact that, despite considerable efforts made by many state parties, large quantities of reptile skins are still being sent illegally from South America, therefore endangering the fauna of these countries. The situation could compromise the efforts of South American countries that wish to trade their wildlife in a rational way, thus conserving it.'

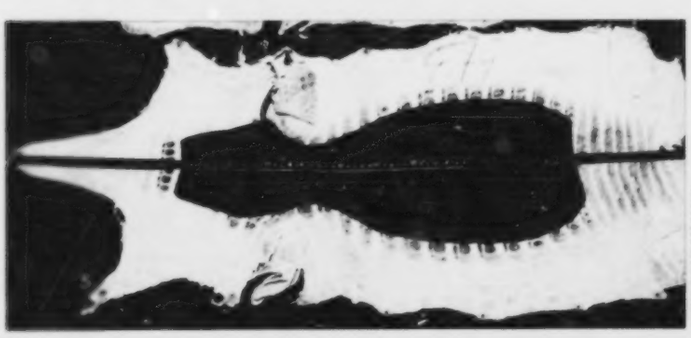
The complexity of the trade in cayman skins was highlighted by two recent confiscations by Italian authorities in Milan. Each shipment contained 5000 skins and had valid permits. But the permits did not correspond to the contents of the shipments, which had been in transit in Curaçao and Panama.

The cayman

This member of the alligator family is found only in Colombia. They are endangered there and it is illegal to take them from the wild, although they are farmed.

Commercially grown captive animals are never grown to more than 1.2 metres long (including the tail), because it is uneconomic to grow them longer than this. The chalecos (skins with the hole in the middle) shown here are approximately 1 metre long and exclude the tail, so they were probably more than 2 metres long originally. Only animals in the wild grow this long.

The full skins are 1.55 metres long. The back skin is too thick for use in leather goods, so is removed to lower the weight and freight costs.



J.P. Le Duc Secretariat CITES

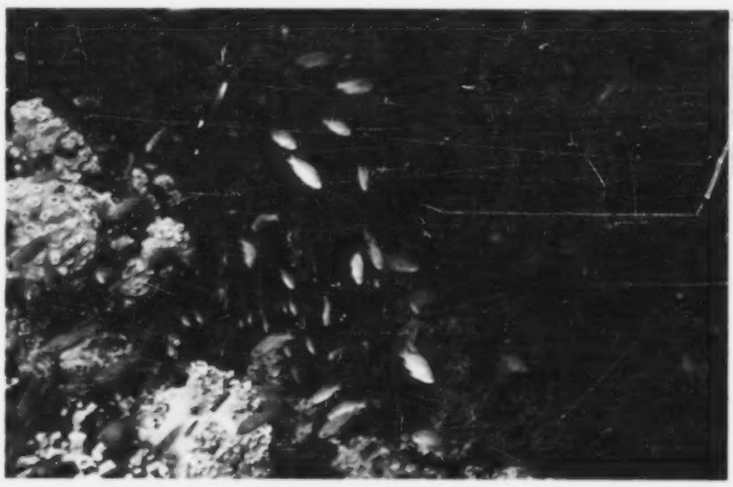
CITES

CITES is the Convention on International Trade in Endangered Species of Wild Fauna and Flora. UNEP provides the Secretariat for the Convention, which is based in Lausanne, Switzerland. The latest signatories to the Convention are Greece and Barbados, bringing the total number of parties to the convention to 118.

The parties to CITES meet every two years, and agree on lists of endangered plant and animal species. Trade in some of the less endangered species is allowed, but only with permits, whereas trade in more endangered animals—such as the African elephant and any products made from it—is banned completely. The implementation of a total ban on trade in elephant products, agreed to at the 1989 CITES meeting, saw the price of ivory collapse and poaching of elephants significantly reduced.

CORAL REEFS FACE PRECARIOUS FUTURE

Eroded topsoil, pollution, hordes of tourists and dynamite fishing are destroying the richest, most beautiful and exciting ecosystems in the marine environment.



Three billion people, 60 percent of the world's population, live in the coastal zone (*see box*). As a result, coastal waters are used as sewage works and rubbish dumps and, it comes as no surprise, are being irreparably damaged as a result. On land, the areas of the greatest biological diversity are tropical rain forests, and their clearance has been the source of enormous worldwide anguish during the past decade. The marine equivalents of the rain forests are coral reefs, and they too now show the signs of humanity's profligate waste disposal, coastal industrialization and development. Clive Wilkinson of the Australian Institute of Marine Science estimated that people have caused the death of 5–10 percent of the world's coral reefs, and another 60 percent may be lost during the next 40 years.

Coral reefs are home to a greater variety of species than any other in the marine environment, yet their submerged plight is less obvious than that of the rain forests.

In the Caribbean, coral reefs are being killed off by the dumping of human waste and heavy metals, the extraction of coral for tourist souvenirs and from being covered in sediment, mostly river-borne eroded topsoil. Controls on the land-based sources of this pollution and erosion, and protection from tourists and coral harvesters, are the only long-term guarantee of protection for these rich, but fragile, ecosystems.

The US State of Florida's famous swampy and estuarine Everglades were drained in the 1970s to prevent urban flooding in the region. As a result, the flow of water from the Everglades into the Florida Keys has been completely altered, increasing salinity and temperatures. The hotter, saltier water is causing the death of many coral reefs in the Keys. Some of the coral which remains is weakened and more susceptible to a bacterial infection called black band disease. Biologist Harold Hudson says that the disease can spread through the coral at a rate of one quarter of an inch per day. 'This disease can kill a 200-year-old coral in less than a year.' In a desperate attempt to stem the flow of the disease, he has developed a vacuum device which he uses to suck the bacteria out of the coral. Although only 70 percent successful, Hudson says that with a 200-year-old coral tree the equivalent of a giant redwood, '... it's worth the effort'.

The State government and the US Army Corp of Engineers are now co-operating in a US$350 million project to return the Everglades to their original condition. This will mean the eventual return of regular freshwater flows into the Florida Keys (*see* Our Planet *Volume 4, Number 4 1992*).

If the causes of the coral destruction can be controlled, there is now some hope of coral reef regeneration. Biologist Hector Guzmán of the Smithsonian Tropical Research Institute in Panama has successfully transplanted coral to damaged reefs around Colombia, Costa Rica and Panama. Thousands of stakes have been wired up with one of three species of the coral *Pocillopora* from Costa Rica's Pacific coast. The stakes have then been imbedded in reefs needing restoration, and after 18 months the coral has bloomed into colonies big enough to survive.

The coastal zone

The coastal zone is that area of land that has an effect on the coast and its waters. It includes the land along the coast itself, the hinterlands where fertilizer seepage runs to the sea and ground-water extraction allows salt-water incursion, and river catchments which contribute eroded topsoil and waste to be carried to the coast.

PUBLICATIONS

STATE OF THE WORLD 1993
Worldwatch Institute, Washington, DC, published by Earthscan, London, 1993.
ISBN 1 85383 135 2

This is the 10th edition of *State of the World*, consistently one of the most easily read sources of accurate up-to-date information available, and the 10th edition is in keeping with its predecessors. As well as the state of the world environment, the book contains chapters on: water scarcity; coral reefs; women and development; indigenous peoples; energy in developing countries; rail transport; arms reduction; trade and the environment; and 'The Next Industrial Revolution'.

THE EARTH SUMMIT'S AGENDA FOR CHANGE: a plain-language version of Agenda 21 and the other Rio agreements
Michael Keating, published by the Centre for Our Common Future, Geneva, 1993.
ISBN 2-940070-00-8.

There has never been a more vaunted gathering of as many world leaders, nor a more important goal than that at Rio de Janeiro in June 1992. While Rio was not intended to provide a burst of original ideas, it did represent an unprecedented show of political will for environmental issues, for a future where humans would not destroy the Earth on which they depend. The commitment to these ideas was a vast tome called Agenda 21, and it was accompanied by two conventions: one on climate change, the other on biodiversity. Agenda 21 was not written for casual reading; its wording was studied for a year before it was signed.

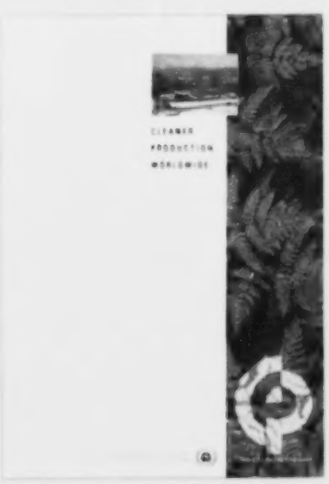
Michael Keating's book is designed for quick, simple reference and is an accessible version of the agenda which lays out how we should change our relationship with the Earth. As prescriptions go, they do not come any more important than that at the heart of this book.

SOLAR PUMPING: an introduction and update on the technology, performance, costs, and economics
Roy Barlow, Bernard McNelis and Anthony Derrick, published by the World Bank, Washington, DC, and Intermediate Technology Publications, London, 1993.

Solar power is the great hope of the future: for the developing world, which has little money but lots of free solar energy; and for the whole planet, which desperately needs an energy source that does not contribute greenhouse gases to an atmosphere already bulging with these gases.

This book presents encouraging practical examples of solar energy being used to pump water, its cost effectiveness and the lessons learned since solar energy was first used in the mid-1970s. It contains technical information, and is a useful guide for those looking to the Sun for their energy needs.

CLEANER PRODUCTION WORLDWIDE
Published by UNEP's Industry and Environment Programme Activity Centre (IE/PAC) and the Department of the Environment of the United Kingdom, 1993.
ISBN 92-807-1369-8.



As illustrated by the cover story in this issue of *Our Planet*, cleaner production is the outcome of the argument that it is cleaner, more sensible and more profitable to avoid unnecessary use of materials and energy. The material costs to the firm or business are lower, as are the costs to the environment, which are really production costs avoided by the producer.

This book should serve as an inspiration to engineers, managers and directors all around the world, because it contains straightforward examples of particular enterprises which have rethought their whole operation to make it cleaner and more profitable, removing the need for expensive end-of-pipe treatment facilities, or expensive law suits and clean-up operations. The global spread of the examples in the book is impressive: Austria, Denmark, France, Greece, India, Indonesia, The Netherlands, Poland, Singapore, Sweden, the United Kingdom and the United States.

Examples range from low- to high-technology, and cover small, medium and large enterprises in areas ranging from villages to crowded industrial cities. In some cases, the process has involved no capital expenditure at all; in others, extensive redesign has been needed. But in all cases, cleaner production has paid for itself and made profits within a very short period of time.

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